Introduction

Gulfstream evaluated G-IV airplane performance data with a computer analysis of a 3° - 4° per second pitch rate to a final pitch attitude of 15° nose up and 20° nose up. The computer analysis indicated that additional energy was available with the Gulfstream airplane and could be used for further altitude gain. Subsequently, simulator tests and verification flight tests in the Gulfstream IV were accomplished to verify that greater performance indeed was available.

Four scenarios were evaluated for the Gulfstream IV.

1. Flaps 20, Max Takeoff weight (74,600 lbs), gear up, V_2 (150 KCAS)
2. Flaps 0, max landing weight (66,000 lbs), gear up, maneuvering speed (206 KCAS).
3. Flaps 20, max landing weight, gear down, V_{ref} +10 (163 KCAS)
4. Flaps 39, max landing weight, gear down, V_{ref} +5 (154 KCAS)

Simulator and Airplane Test Procedure

1. Establish flight condition and airplane configuration.
2. At start of maneuver, advance throttles to max continuous thrust and initiate pitch up at 3 to 4 deg/sec rate.
3. When pitch attitude reaches 35 degrees (± 5 degrees), lower nose to achieve and maintain V_{ref} -20.
4. Continue at V_{ref} -20 for at least 30 seconds. (Shaker should not be triggered but if it is, respond appropriately.)

Conclusions

It is concluded based upon the results of both simulation and flight test that the CFIT escape maneuver as shown in Figure 1 is confirmed to be effective over a range of starting flight conditions. Figures show that the pitch angle was quickly increased as specified at the start of each maneuver. Maximum pitch attitudes reached in flight range from 26° to 39°. Simulator results agree closely.

The altitude time histories indicate an initial zoom climb, followed by a sustained climb at a lessor rate. This is a desirable profile, since in a CFIT avoidance situation, one needs to acquire as much altitude as quickly as possible.

The escape maneuver of Figure 1, although derived from GIV flight test and simulation, was determined by computer analysis to also apply to GII and GIII aircraft.

FIGURE 1

CFIT ESCAPE MANEUVER FOR GULFSTREAM AIRCRAFT

APPLICABLE TO GII, GIII, AND GIV

Upon receipt of a GPWS warning, the following procedure must be immediately executed:

A. Disconnect the Autopilot and apply Go-Around Power.

B. Rotate at 3-4 degrees/second to increase pitch attitude to the highest possible value. (A pitch attitude of 25 degrees has been demonstrated on the GIV at maximum landing weight with flaps at 39 degrees)

C. When stick shaker is encountered, or as V_{ref} is approached, reduce pitch rate/angle of attack to intercept V_{ref} -20 KCAS.

D. Check power setting.

E. Monitor Radar altimeter.

NOTE: Analysis and flight simulation have consistently shown that the highest altitude gain results from pitching at the highest rate to the highest angle while decelerating as quickly as possible to the lowest acceptable airspeed. Flight test demonstrated that a pitch attitude of 40 degrees can be reached and 25 degrees can be sustained at light weight on the GIV.

FIGURE 2

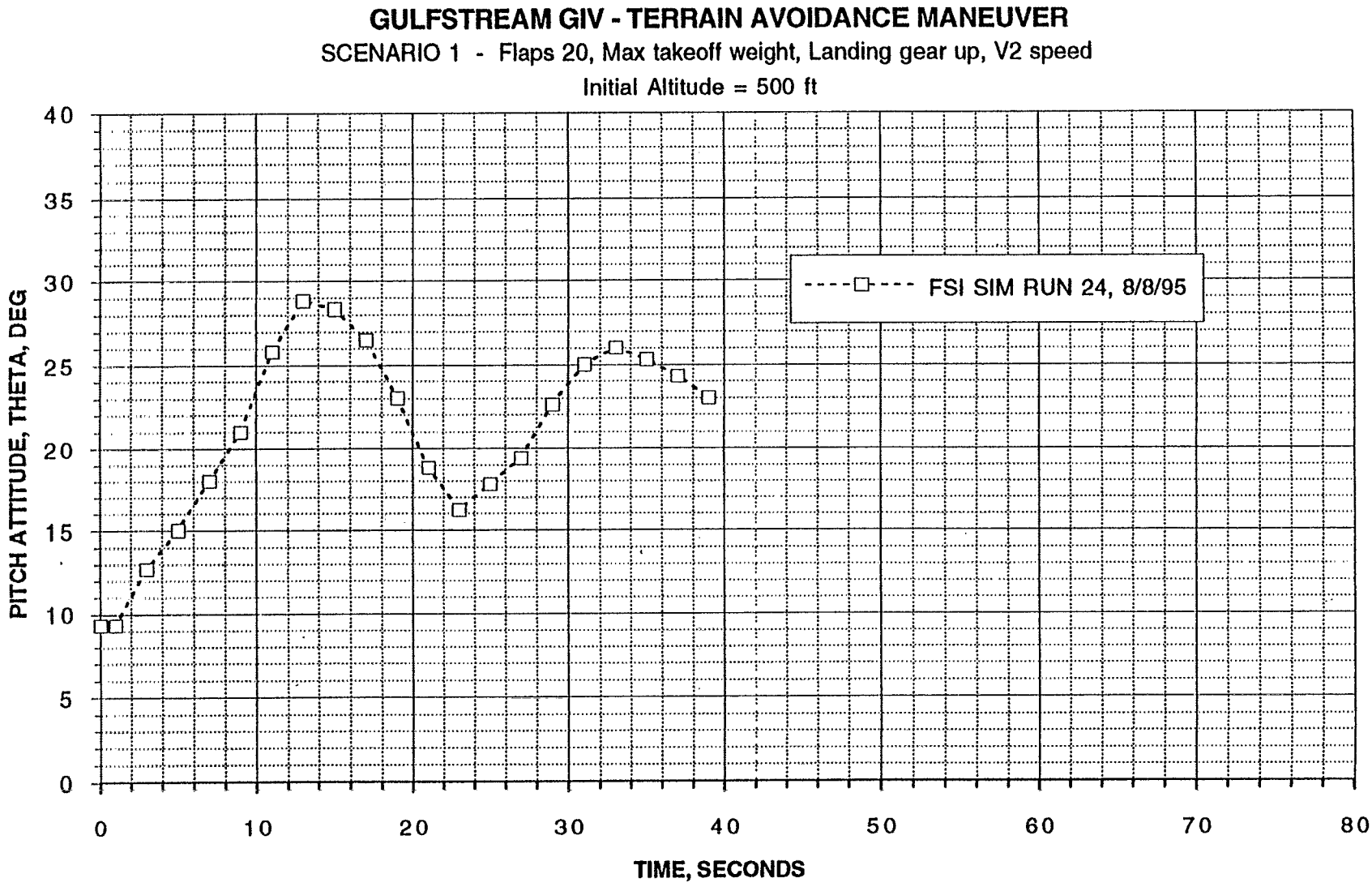

GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 1 - Flaps 20, Max takeoff weight, Landing gear up, V2 speed
Initial Altitude = 500 ft
PITCH ATTITUDE, THETA, DEG
TIME, SECONDS
FSI SIM RUN 24, 8/8/95
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80

FIGURE 3

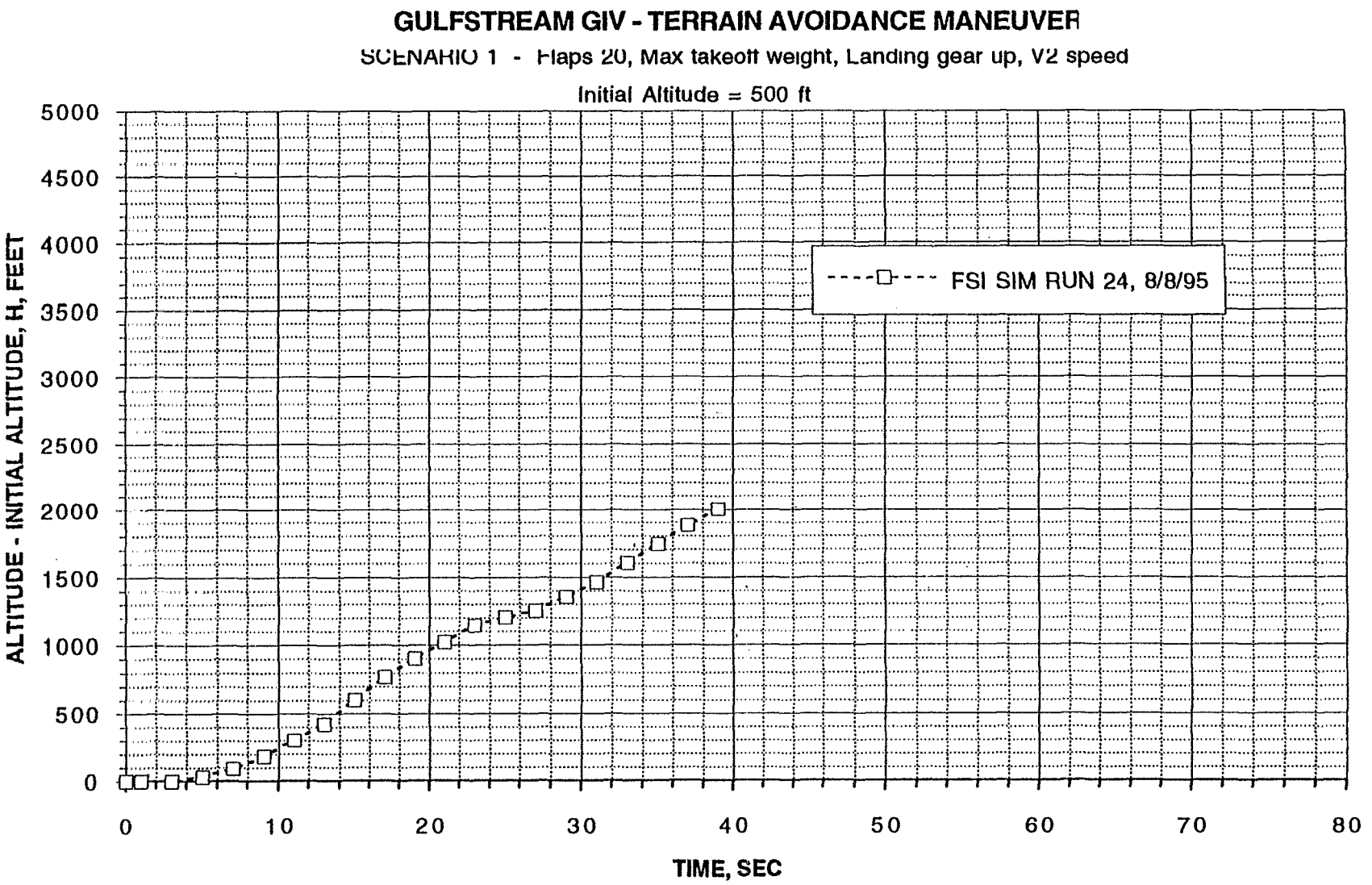

GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 1 - Flaps 20, Max takeoff weight, Landing gear up, V2 speed
Initial Altitude = 500 ft
ALTITUDE - INITIAL ALTITUDE, H, FEET
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
TIME, SEC
FSI SIM RUN 24, 8/8/95

FIGURE 4

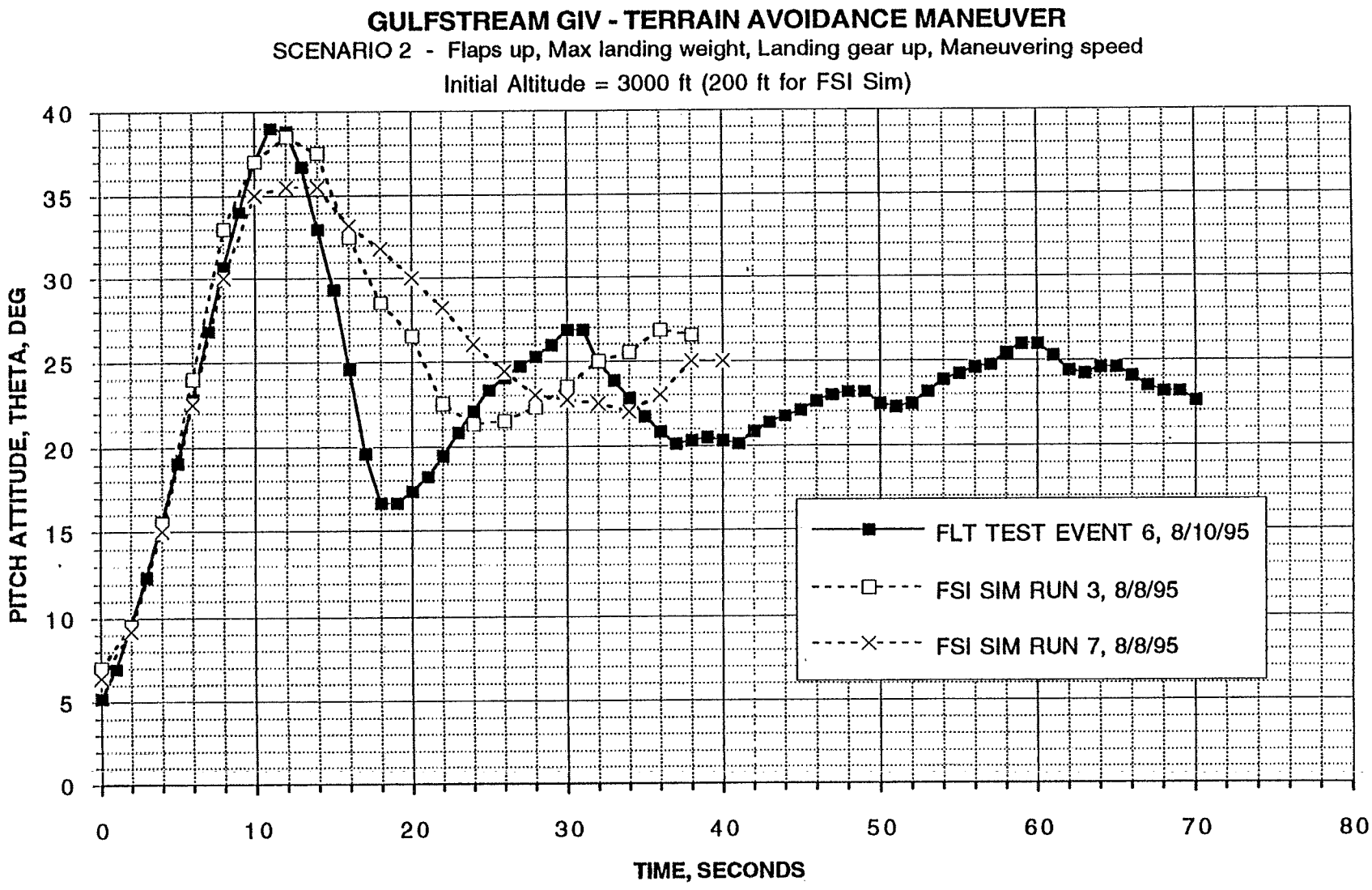

GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 2 - Flaps up, Max landing weight, Landing gear up, Maneuvering speed
Initial Altitude = 3000 ft (200 ft for FSI Sim)
PITCH ATTITUDE, THETA, DEG
TIME, SECONDS
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
FLT TEST EVENT 6, 8/10/95
FSI SIM RUN 3, 8/8/95
FSI SIM RUN 7, 8/8/95

FIGURE 5

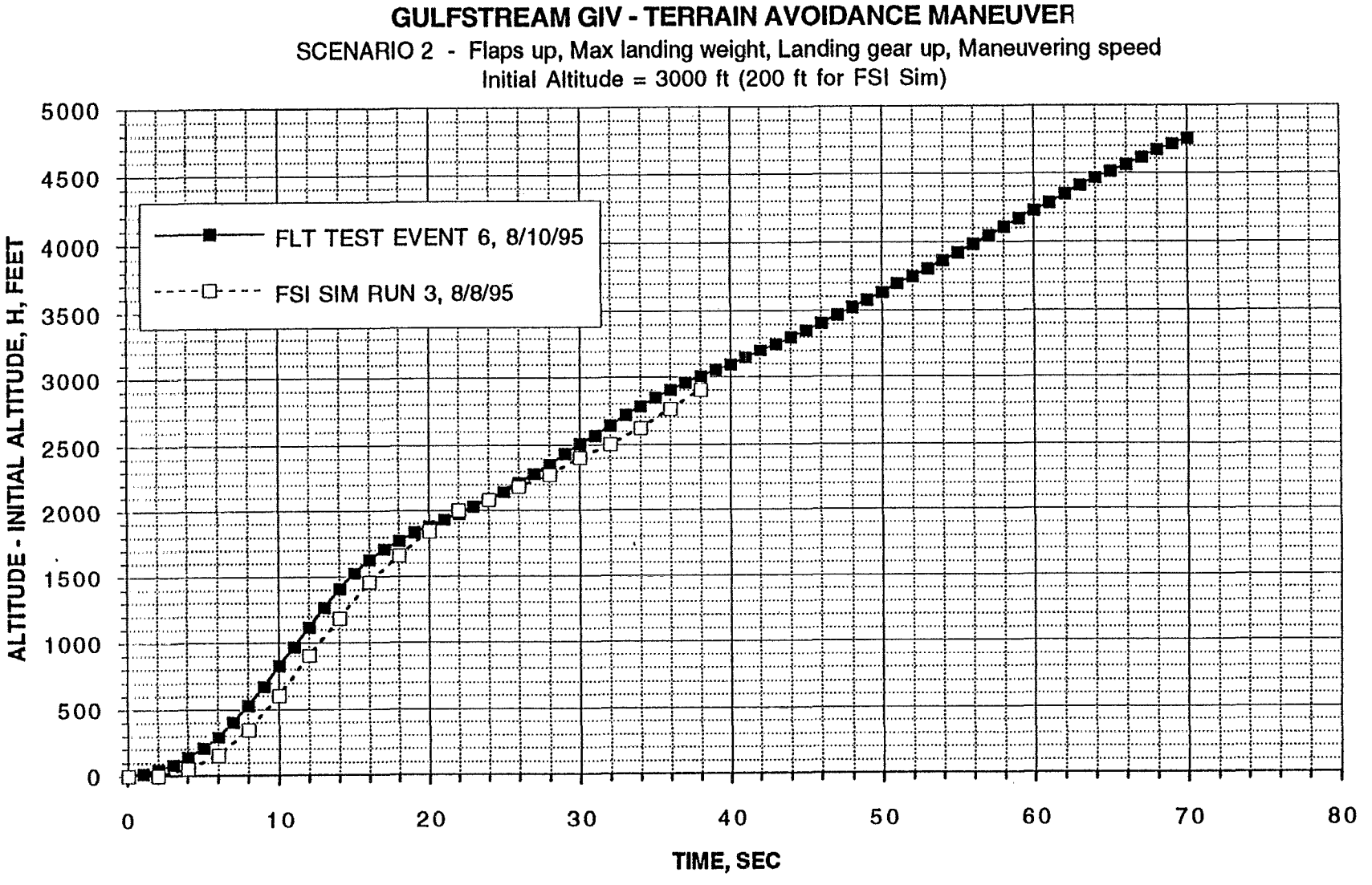

GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 2 - Flaps up, Max landing weight, Landing gear up, Maneuvering speed
Initial Altitude = 3000 ft (200 ft for FSI Sim)
FLT TEST EVENT 6, 8/10/95
FSI SIM RUN 3, 8/8/95
ALTITUDE - INITIAL ALTITUDE, H, FEET
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
TIME, SEC

FIGURE 6

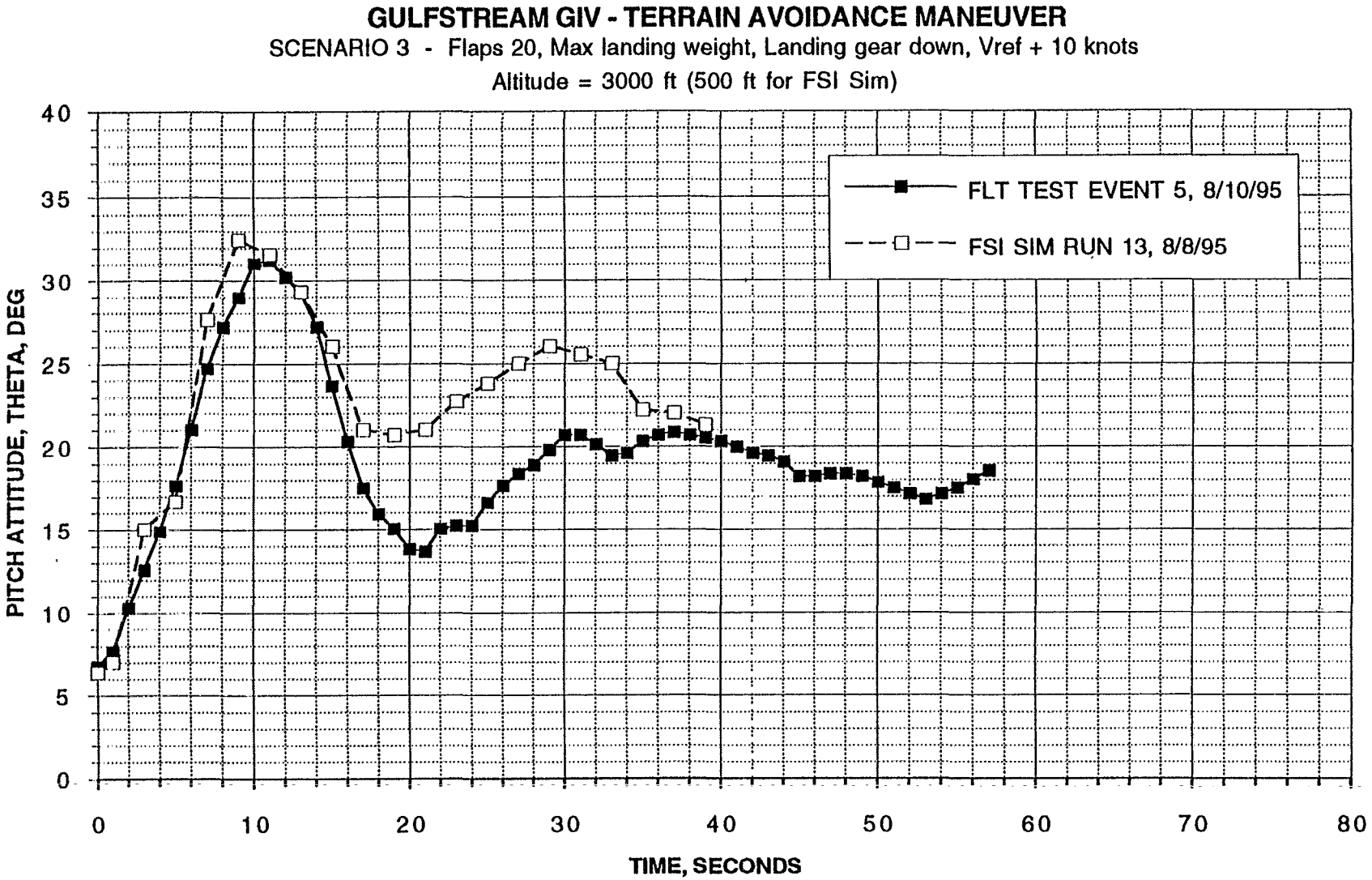

GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 3 - Flaps 20, Max landing weight, Landing gear down, Vref + 10 knots
Altitude = 3000 ft (500 ft for FSI Sim)
FLT TEST EVENT 5, 8/10/95
FSI SIM RUN 13, 8/8/95
PITCH ATTITUDE, THETA, DEG
TIME, SECONDS
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80

FIGURE 7

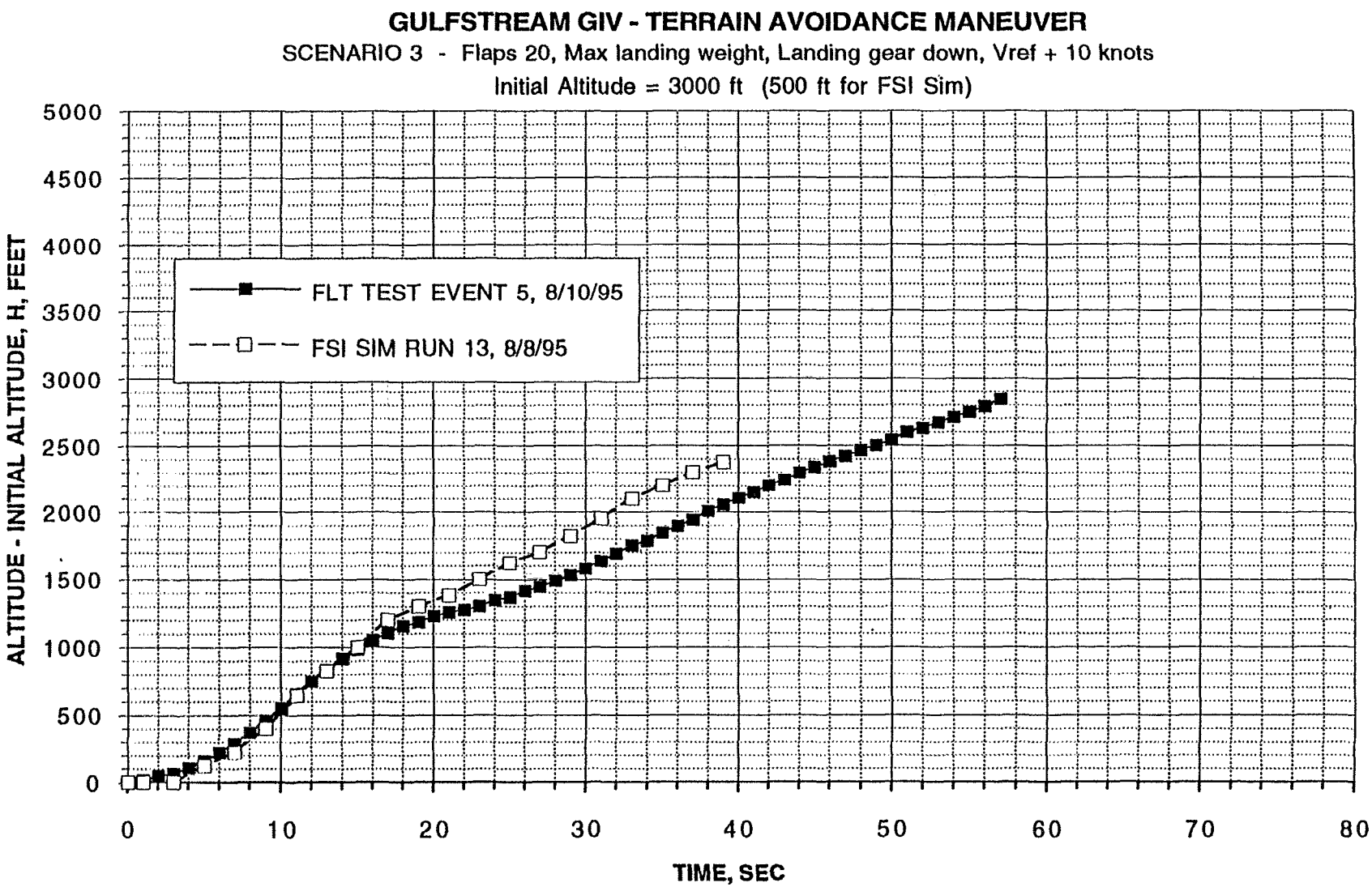
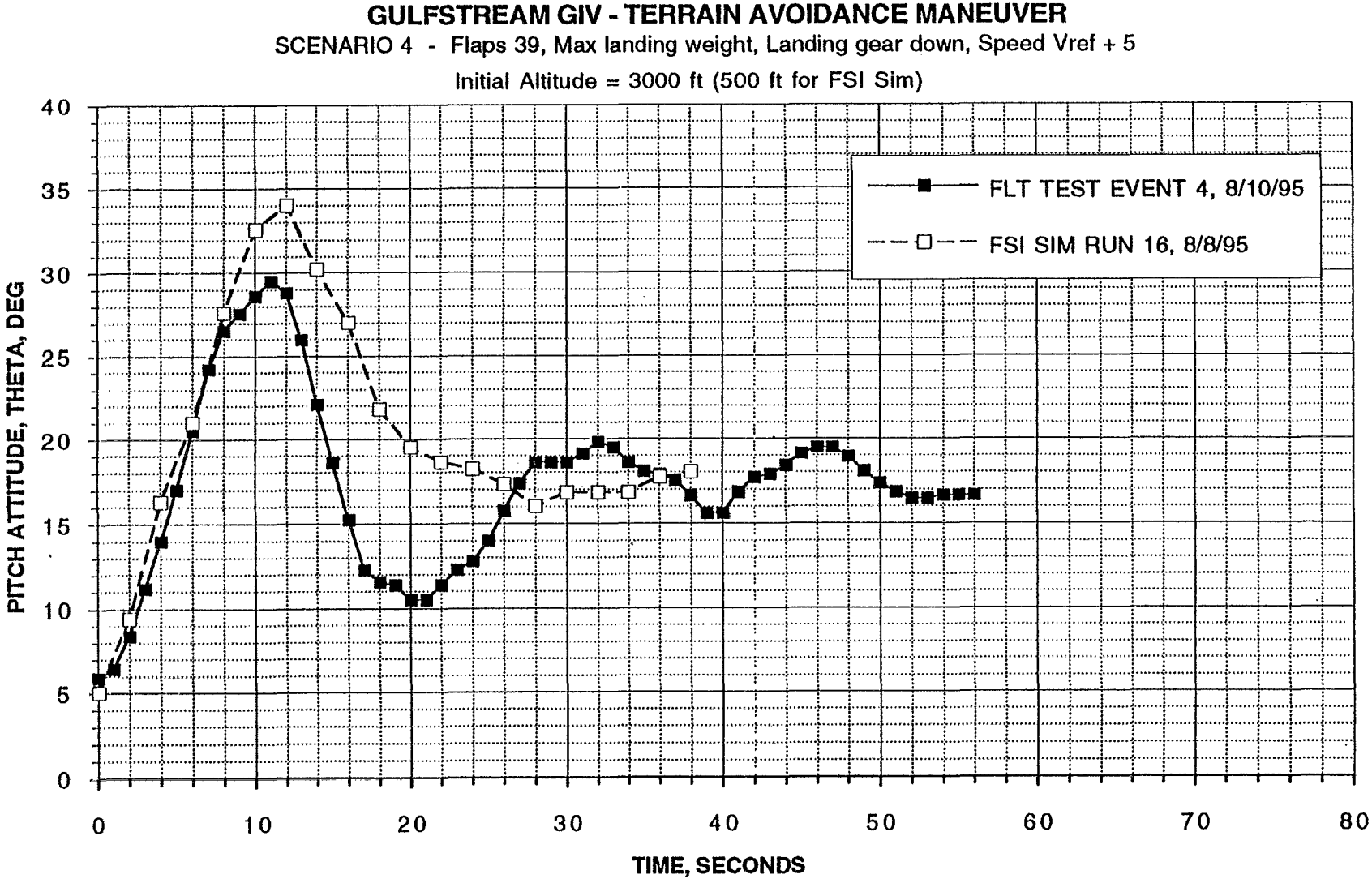

GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 3 - Flaps 20, Max landing weight, Landing gear down, Vref + 10 knots
Initial Altitude = 3000 ft (500 ft for FSI Sim)
ALTITUDE - INITIAL ALTITUDE, H, FEET
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
FLT TEST EVENT 5, 8/10/95
FSI SIM RUN 13, 8/8/95
0
10
20
30
40
50
60
70
80
TIME, SEC

FIGURE 8


GULFSTREAM GIV - TERRAIN AVOIDANCE MANEUVER
SCENARIO 4 - Flaps 39, Max landing weight, Landing gear down, Speed Vref + 5
Initial Altitude = 3000 ft (500 ft for FSI Sim)
FLT TEST EVENT 4, 8/10/95
FSI SIM RUN 16, 8/8/95
PITCH ATTITUDE, THETA, DEG
TIME, SECONDS
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80

Go To Next Section

FIGURE 9